



Instituto Superior de Economia e Gestão

UNIVERSIDADE TÉCNICA DE LISBOA

A 4ª Revolução Industrial

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Aula ISEG
25-Nov-2016

A 4ª Revolução Industrial

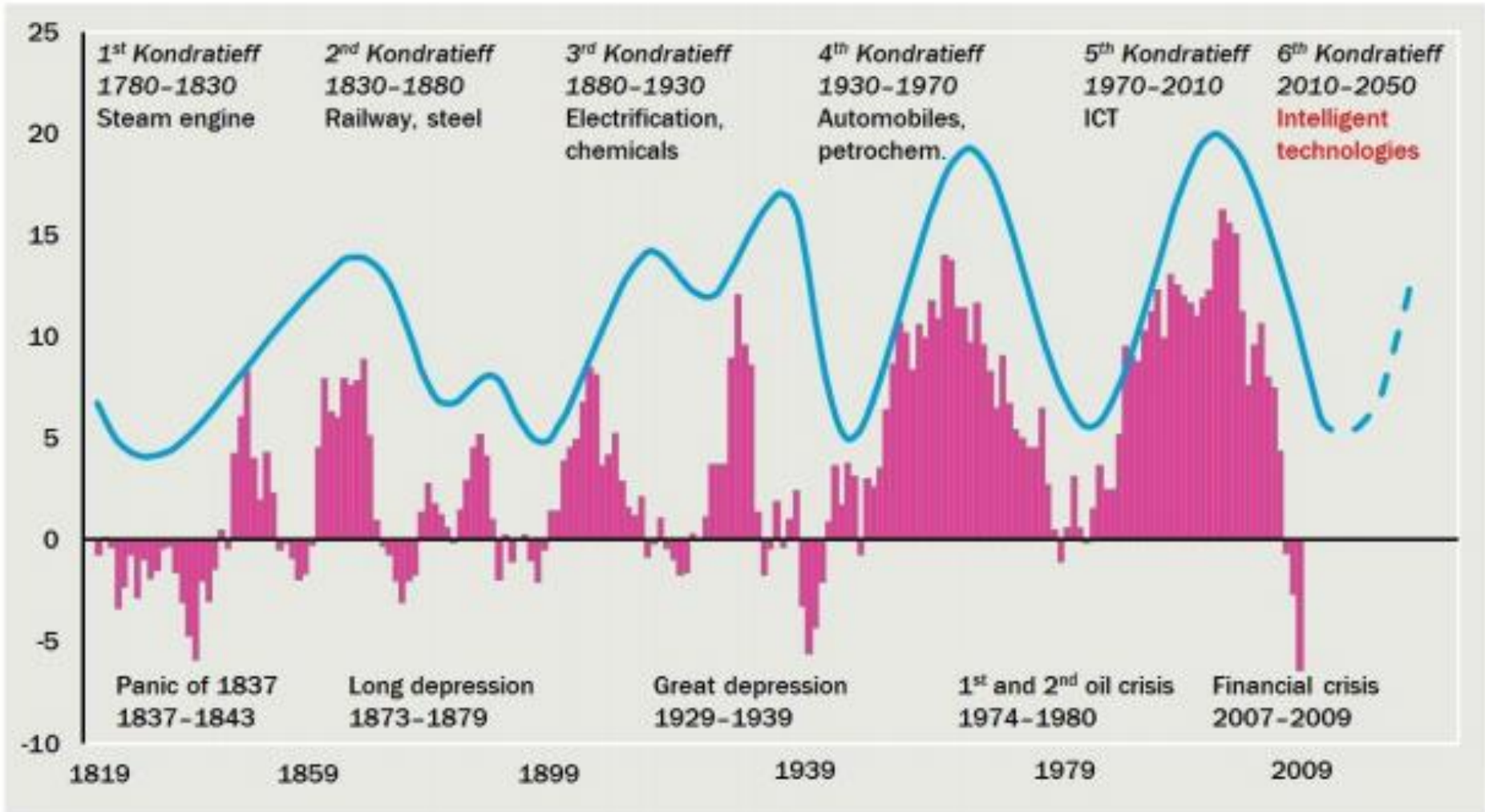
1. Como chegámos aqui
 - os pressupostos
2. Onde estamos
 - o fim da 3ª revolução industrial
3. O que estamos a fazer
 - 4ª revolução industrial
4. O impacto da 4ª RI
 - o que muda, valor económico
5. O que falta e os perigos
 - investimento, maturação, energia, legislação, economia
6. Conclusão

*Foco no
desenvolvimento
e impacto da
tecnologia*

COMO CHEGÁMOS AQUI

A HISTÓRIA REPETE-SE

Surtos de desenvolvimento *e tecnologia*

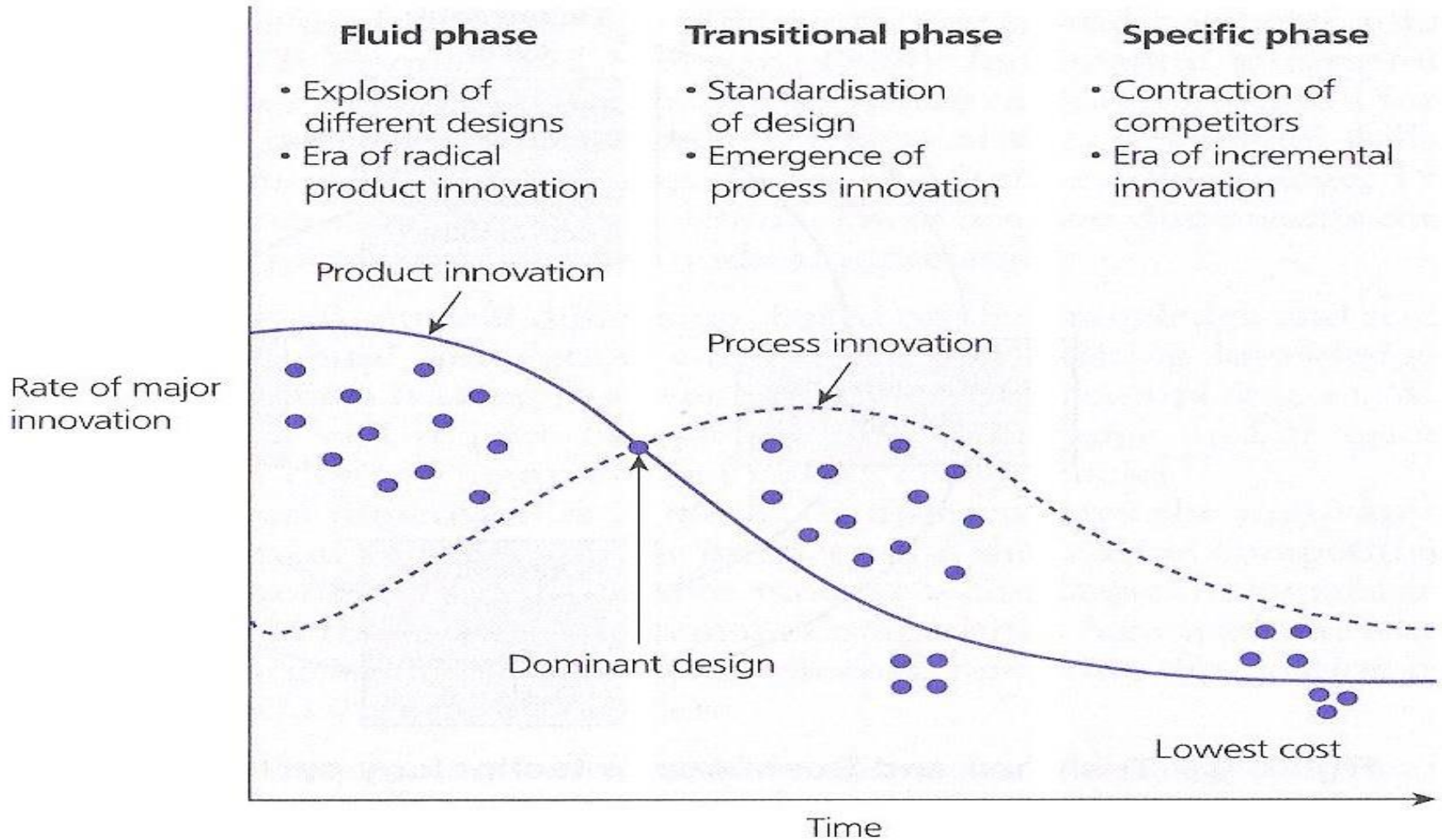


SURFING THE SIXTH WAVE

Exploring the next 40 years of global change

Markku Wilenius and Sofi Kurki

Difusão, assimilação e domínio tecnológico



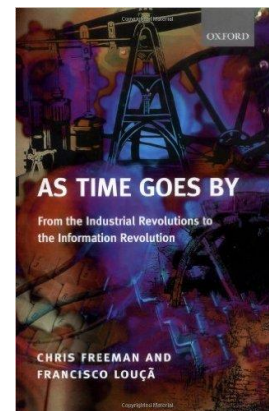
Abernathy and Utterback's three phases of innovation

Source: Utterback (1994).

Combinação de fatores

TABLE II.1. Condensed summary of the Kondratiev waves

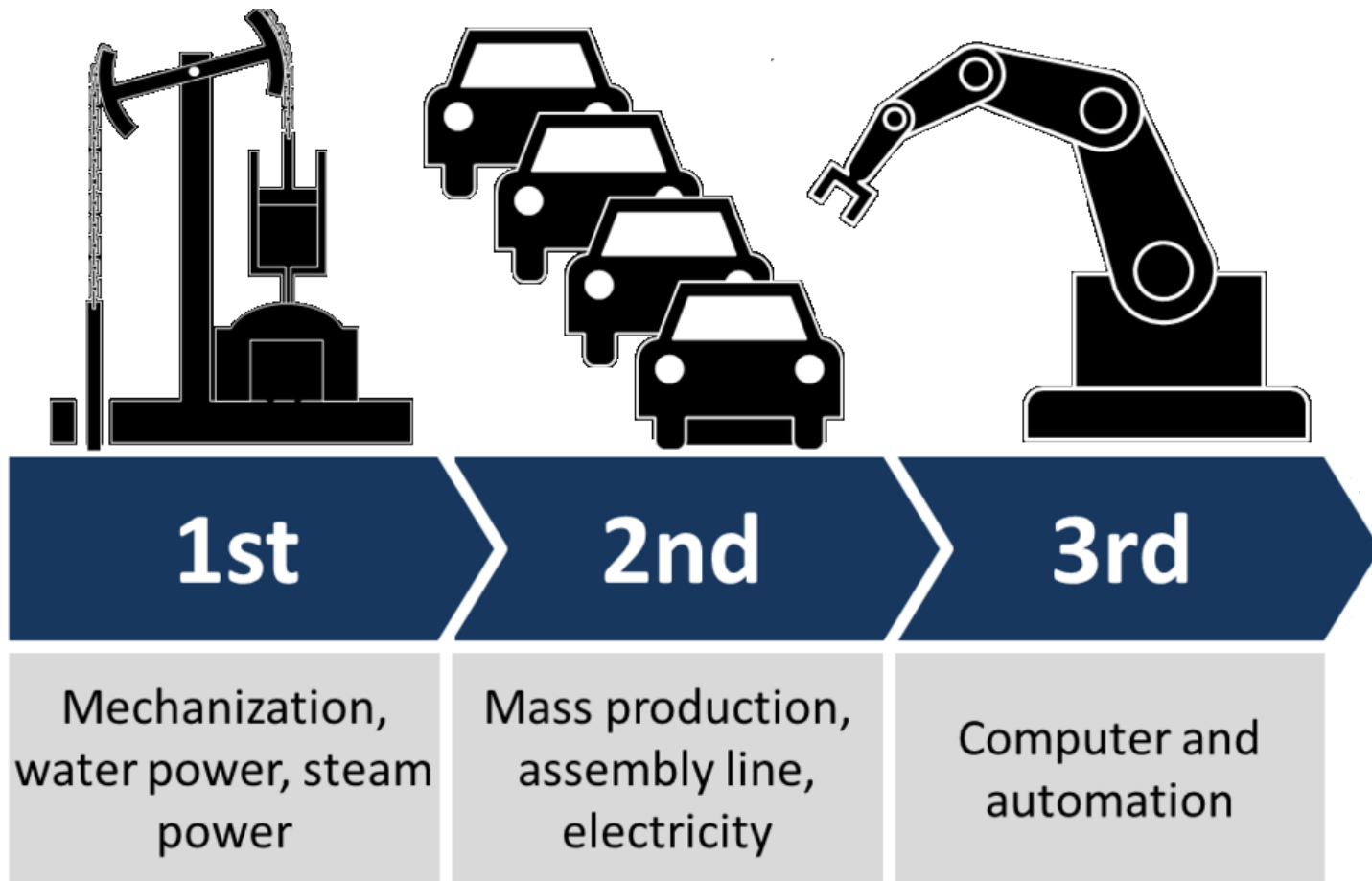
Constellation of technical and organizational innovations	Examples of highly visible, technically successful, and profitable innovations	'Carrier' branch and other leading branches of the economy	Core input and other key inputs	Transport and communication infrastructure	Managerial and organizational changes	Approx. timing of the 'upswing' (boom) <hr/> 'downswing' (crisis of adjustment) (7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Water-powered mechanization of industry	Arkwright's Cromford mill (1771) Henry Cort's 'puddling' process (1784)	Cotton spinning Iron products Water wheels Bleach	Iron Raw cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s–1815 <hr/> 1815–1848
2. Steam-powered mechanization of industry and transport	Liverpool–Manchester Railway (1831) Brunel's 'Great Western' Atlantic steamship (1838)	Railways and railway equipment Steam engines Machine tools Alkali industry	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848–1873 <hr/> 1873–1895
3. Electrification of industry, transport, and the home	Carnegie's Bessemer steel rail plant (1875) Edison's Pearl St. New York Electric Power Station (1882)	Electrical equipment Heavy engineering Heavy chemicals Steel products	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism' Giant firms	1895–1918 <hr/> 1918–1940
4. Motorization of transport, civil economy, and war	Ford's Highland Park assembly line (1913) Burton process for cracking heavy oil (1913)	Automobiles Trucks Tractors, tanks Diesel engines Aircraft Refineries	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption 'Fordism' Hierarchies	
5. Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel microprocessor (1972)	Computers Software Telecommunication equipment Biotechnology	'Chips' (integrated circuits)	'Information Highways' (Internet)	Networks; internal, local, and global	



ONDE ESTAMOS

A Infraestrutura - As inovações base

A 3ª Revolução industrial



Onde estamos

Fase 1 – A era das TIC (Y2K Bug)



Onde estamos

Fase 1 – A era das TIC

Global IP Traffic & Service Adoption Drivers

By 2019:



More Internet Users



2014	2019
2.8 Billion	3.9 Billion

More Devices & Connections



2014	2019
14.2 Billion	24.4 Billion

Faster Broadband Speeds



2014	2019
20.3 Mbps	42.5 Mbps

More Video Viewing



2014	2019
67% of Traffic	80% of Traffic

Onde estamos

Fase 2 – “Big Data Analytics”

THE BIG DATA ERA

VOLUME
VARIETY
VELOCITY
VALUE

DATA SIZE

BIG DATA

INFORMATION OVERLOAD

RELEVANT DATA

TODAY

THE FUTURE

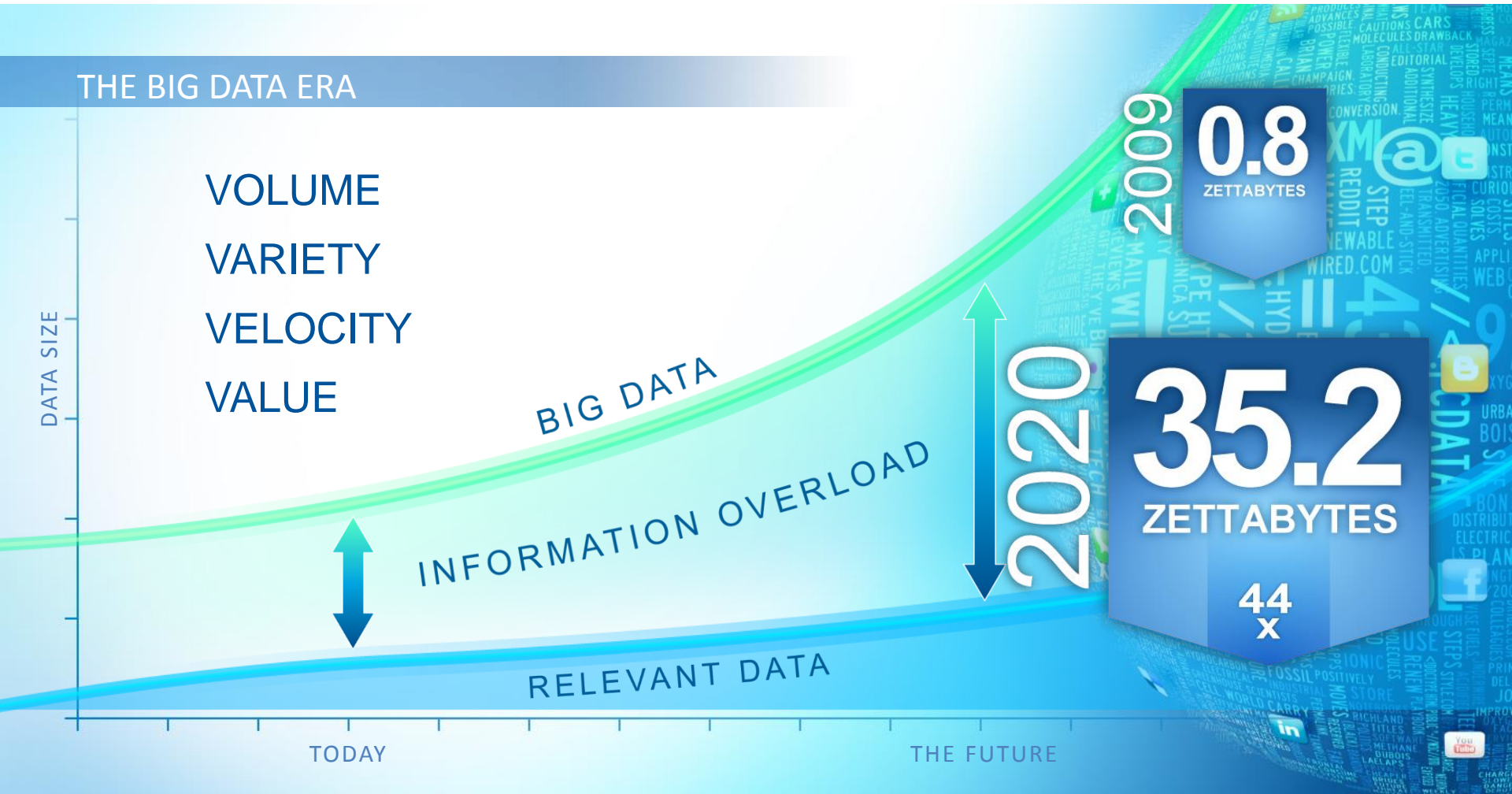
2009

0.8
ZETTABYTES

2020

35.2
ZETTABYTES

44
X



Onde estamos

Fase 2 – Big Data Analytics

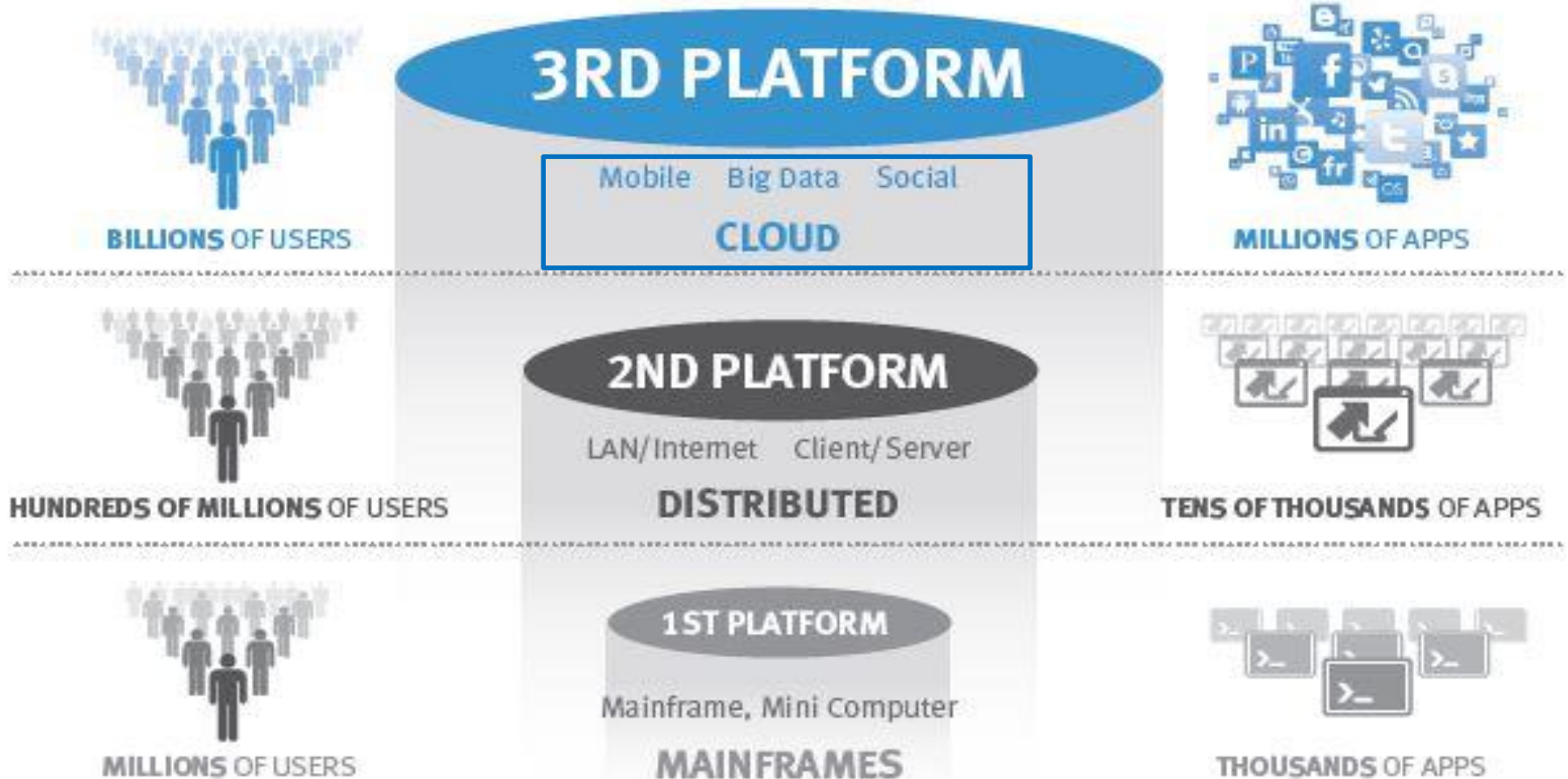
- “We create as much information in two days now as we did from the dawn of man through 2003.”
Eric Schmidt at Techonomy (2010); <http://techcrunch.com/2010/08/04/schmidt-data/>
- “Every day, we create 2.5 quintillion (Eb) bytes of data”
IBM (2013); <http://www-01.ibm.com/software/data/bigdata/what-is-big-data.html>
- “A full 90% of all the data in the world has been generated over the last two years.”
SINTEF (2013); <http://www.sintef.no/home/Press-Room/Research-News/Big-Data--for-better-or-worse/>
- “From now until 2020, the digital universe will about double every two years.”
IDC (2012); <http://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf>
- “nearly half of all the people in the world have access to the Internet – 46%”
Internet World Stats (2015); <http://www.internetworldstats.com/>

Onde estamos

Fase 3 – A 3ª plataforma de TIC

THE THIRD PLATFORM

The Third Platform is described by IDC as the next-generation compute platform that is accessed from mobile devices, utilizes Big Data, and is cloud based.

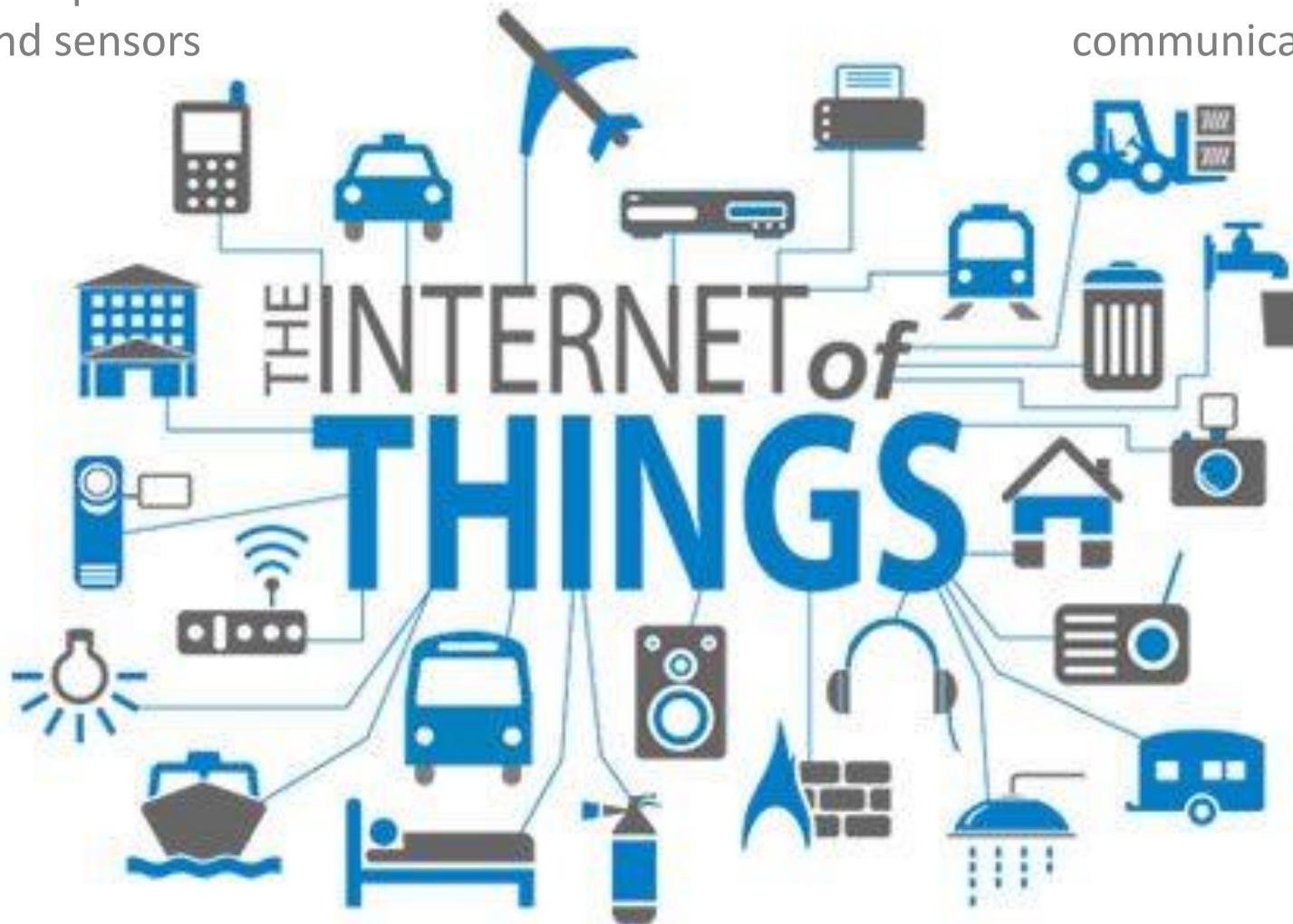


Onde estamos

Fase 4 – Internet das Coisas e Aceleradores

Low cost processors
and sensors

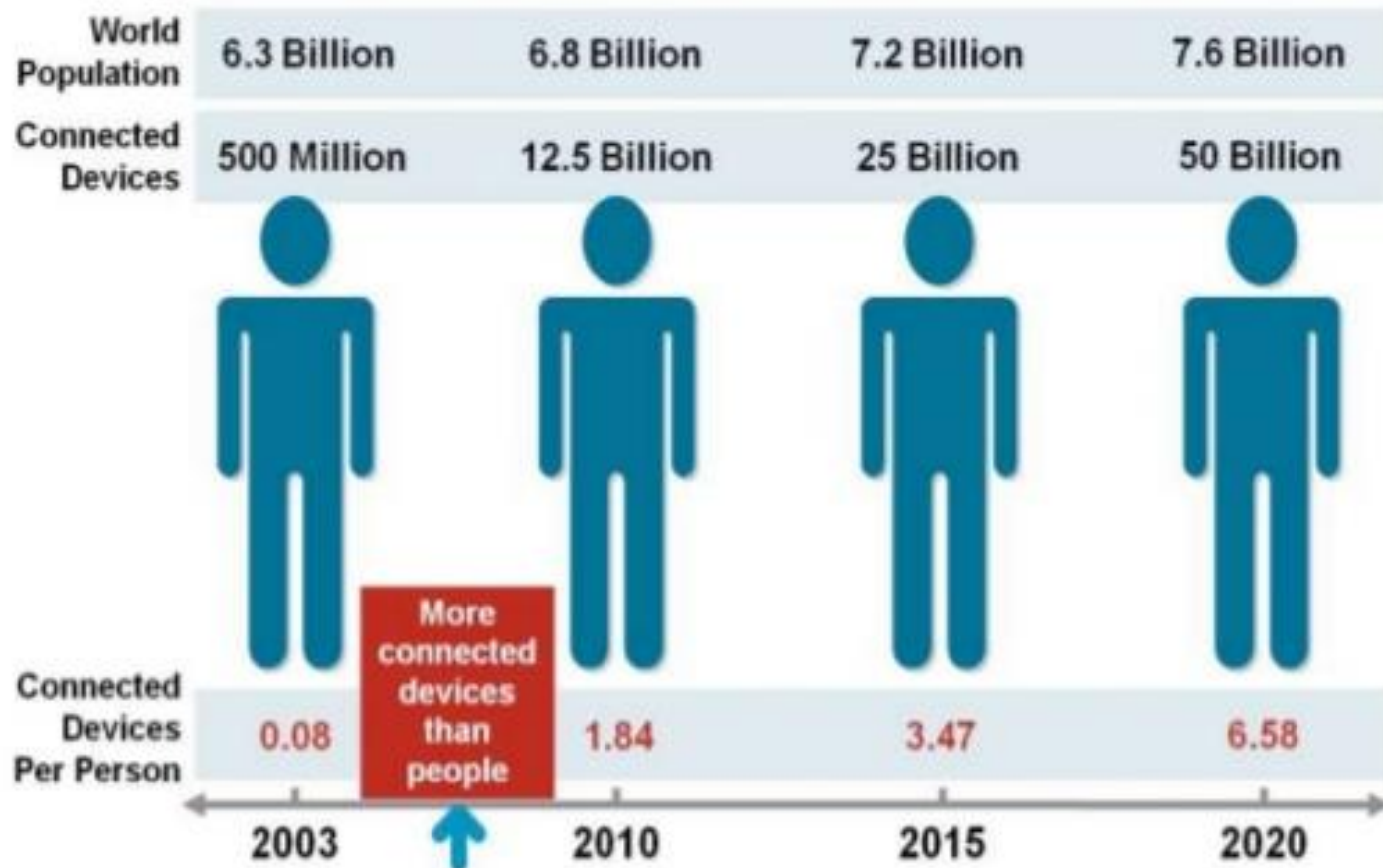
Low cost
communications



Onde estamos

Fase 4 – Internet das Coisas

ACCORDING TO ABI RESEARCH MORE THAN 30 BILLION DEVICES WILL BE WIRELESSLY CONNECTED TO THE INTERNET BY 2020.



Onde estamos

Fase 4 – Internet das Coisas

- “Since 2013, 650 million new physical objects have come online; ... 10 percent of automobiles became connected; ... In 2015, all of these things will double again.”

Gartner (2014) <http://www.gartner.com/newsroom/id/2865519>

- “The number of mobile-connected devices exceeded the world’s population in 2014”
(1.5 in 2019)

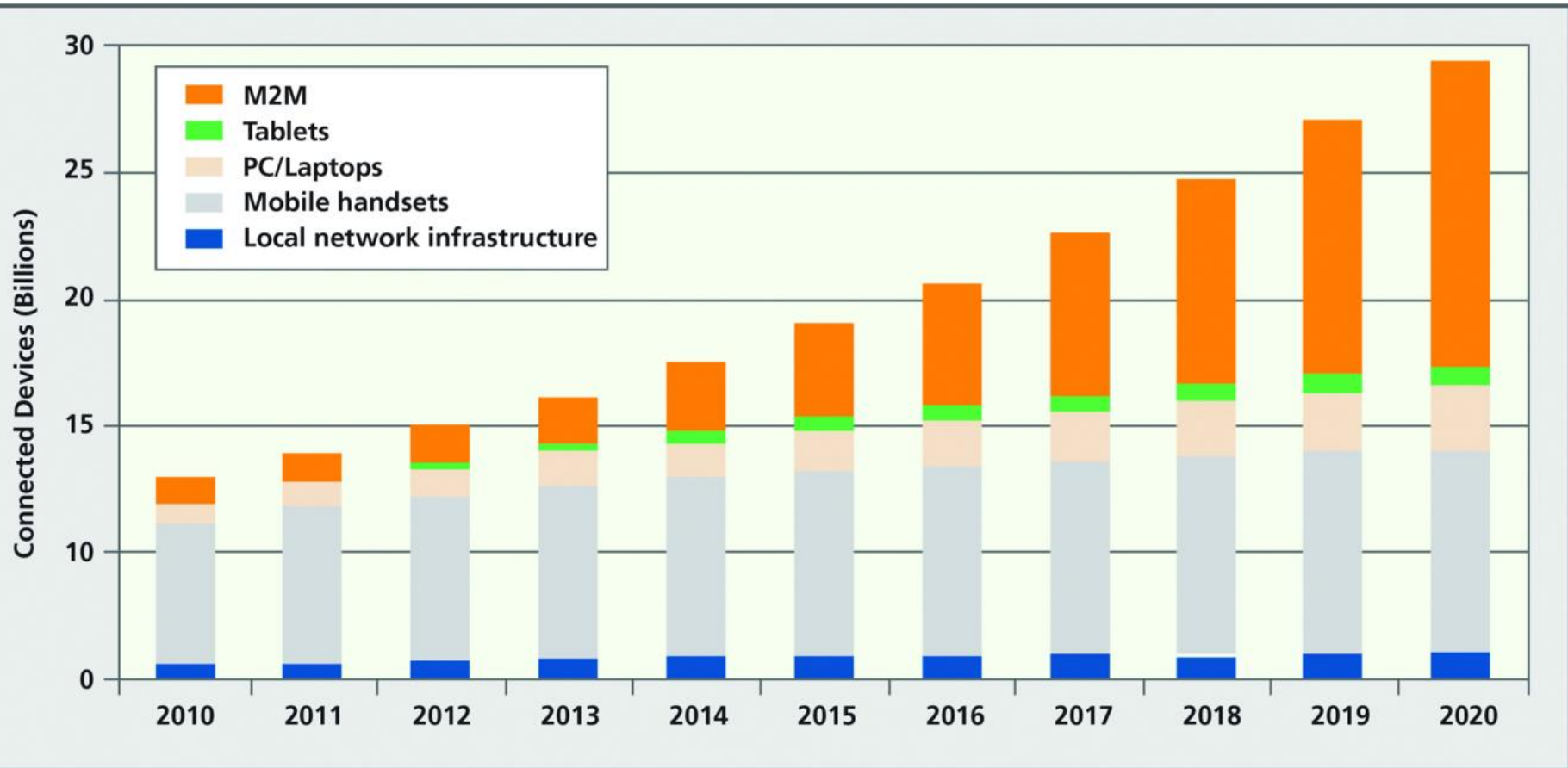
Cisco (2013); http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

- “In 2013, connected “things” were 7% of the total. By 2020, that will grow to 15%”

EMC (2014); <http://www.emc.com/collateral/analyst-reports/idc-digital-universe-2014.pdf>

Onde estamos

Fase 4 – Crescimento dos dispositivos conectados



Onde estamos

Fase 4 – Os aceleradores

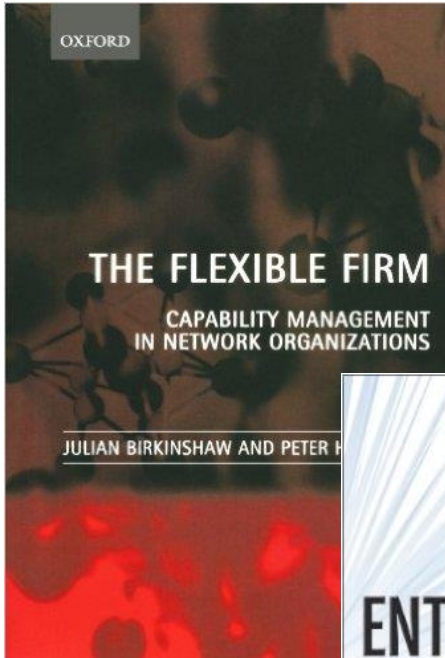


O QUE ESTAMOS A FAZER

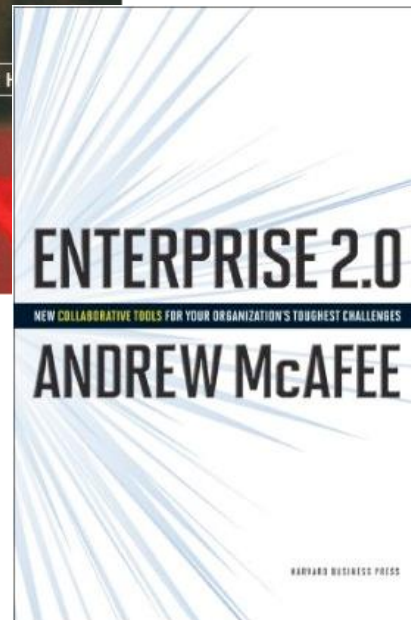
A estrutura - ligando as peças

O que estamos a fazer

Fase 5 – Empresa 2.0



Network-like organizational forms that firms are adopting to make themselves more flexible and responsive to changing technologies and customer demands



Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers

- *Group editing*
- *Authoring*
- *Broadcast Search*
- *Collective Intelligence*
- *Self-organization*

The Flexible Firm – Birkinshaw, Hagstrom (2010)

Enterprise 2.0: The Dawn of Emergent Collaboration – McAfee (2009)

O que estamos a fazer

Fase 5 – Máquina 2.0, iterativa



Rise of the machines

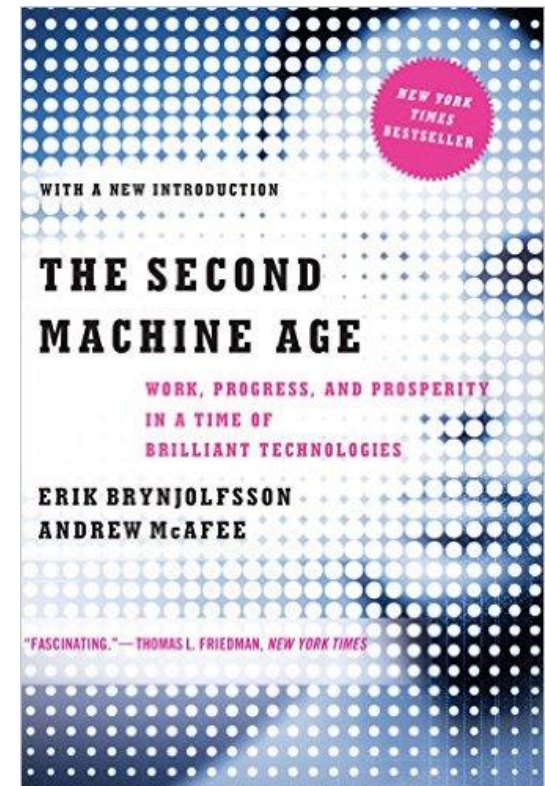
Humanoid robots in development include Atlas, which is being built for the DARPA Robotics Challenge (DRC).

- Sensor array "head"** Two cameras for stereo vision plus a laser rangefinder
- Software** Crowd-sourced and tested in simulations and real-world trials
- Joints** Hydraulically activated for maximum strength
- Hands** Articulated for using tools designed for humans
- Power** External to the robot and supplied by cables

The DARPA Robotics Challenge

- Robot types competing in the DRC in December 2013: **8**
- Number of countries represented: **2** (US and Japan)
- Intended use for production versions: **Disaster relief**

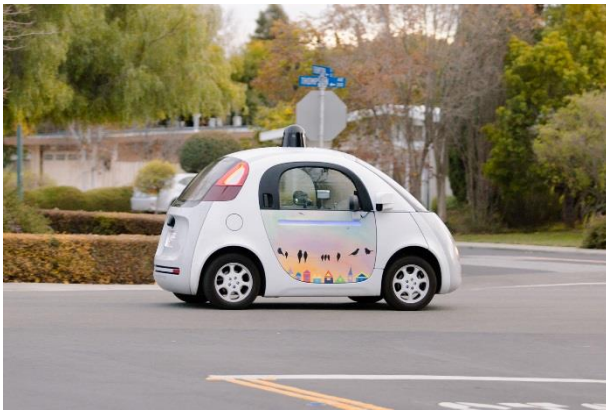
Sources: Boston Dynamics / Darpa



Useless robot waiters fired for incompetence in China
The Telegraph, April 2016

O que estamos a fazer

Fase 5 – Dispositivos 2.0, ligados ao mundo



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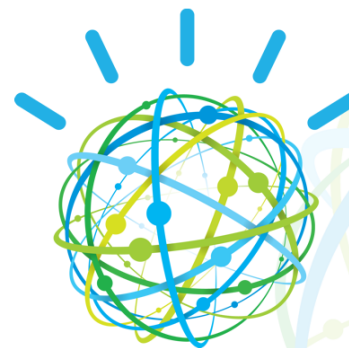
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IBM Watson Analytics

O que estamos a fazer

Fase 5 – Industria 4.0

Harvard
Business
Review



MANAGING ORGANIZATIONS

How Smart, Connected Products Are Transforming Companies

by Michael E. Porter and James E. Heppelmann

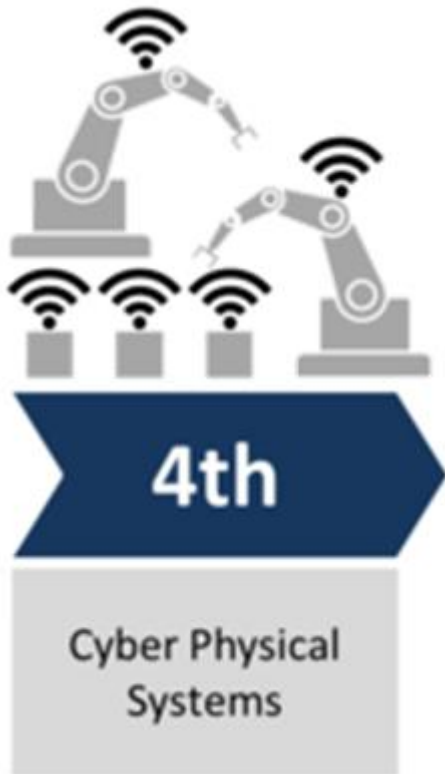
FROM THE OCTOBER 2015 ISSUE

“How the nature of smart, connected products substantially changes the work of virtually every function within the manufacturing firm. The core functions - product development, IT, manufacturing, logistics, marketing, sales, and after-sale service - are being redefined, and the intensity of coordination among them is increasing. Entirely new functions are emerging, including those to manage the staggering quantities of data now available”

**Harvard
Business
Review**

O que estamos a fazer

Fase 5 – Industria 4.0



Industry Internet of Things
Smart Factories
Digital Value Chain Integration

Industry 4.0: is the transformations in the design, manufacture, operation and service of manufacturing systems and products

- *Aplicação TIC: digitalização, internet, cloud, IA*
- *Sistemas ciber-físicos: IoT, robots, drones*
- *Automação: CAD, ERP, BPM (desenho, operação, monitorização)*

Industry 4.0

Digitalisation for productivity and growth

EPRS | European Parliamentary Research Service

Author: Ron Davies

O que estamos a fazer

Fase 5 – Cidades Inteligentes



European Innovation Partnership on Smart Cities and Communities
ROADMAP 2016
Supporting European Smart Cities

What?

To overcome market fragmentation and achieve scale in building a market for smart city innovations

-  Quality of life
-  Business
-  Job creation
-  Low carbon
-  Sustainability

How?

 Public partners +  Private partners →  Co-creating +  Sharing risk

Who?

At least **100** cities to collaborate on bundling demand,
100 industries cooperate and develop solutions

-  **100** cities
-  **100** industry partners
- with the support of:
-  Governments
-  Civil society
-  Academia

O IMPACTO DA 4ª RI

O que muda

O impacto da 4ª RI

Digitalização, Conetividade, Tempo-real, Social



O impacto da 4ª RI

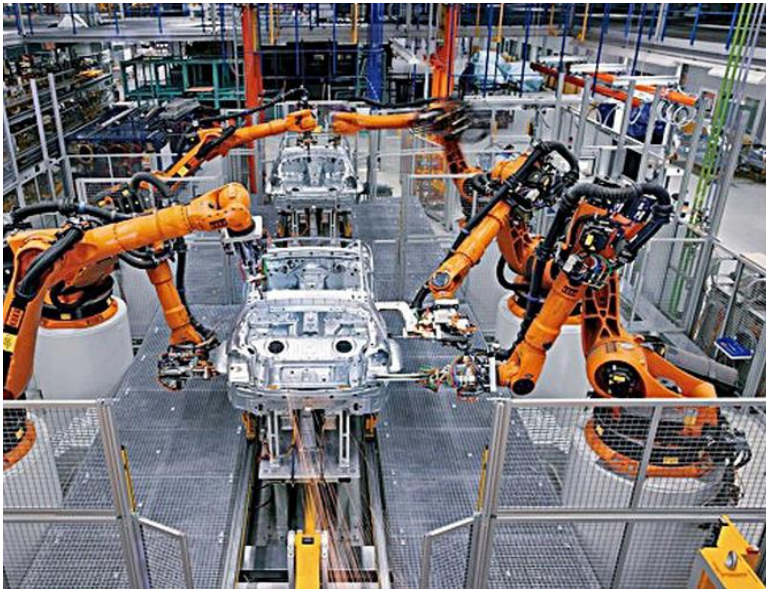
Desmaterialização



Digitalização produtos e serviços

O impacto da 4ª RI

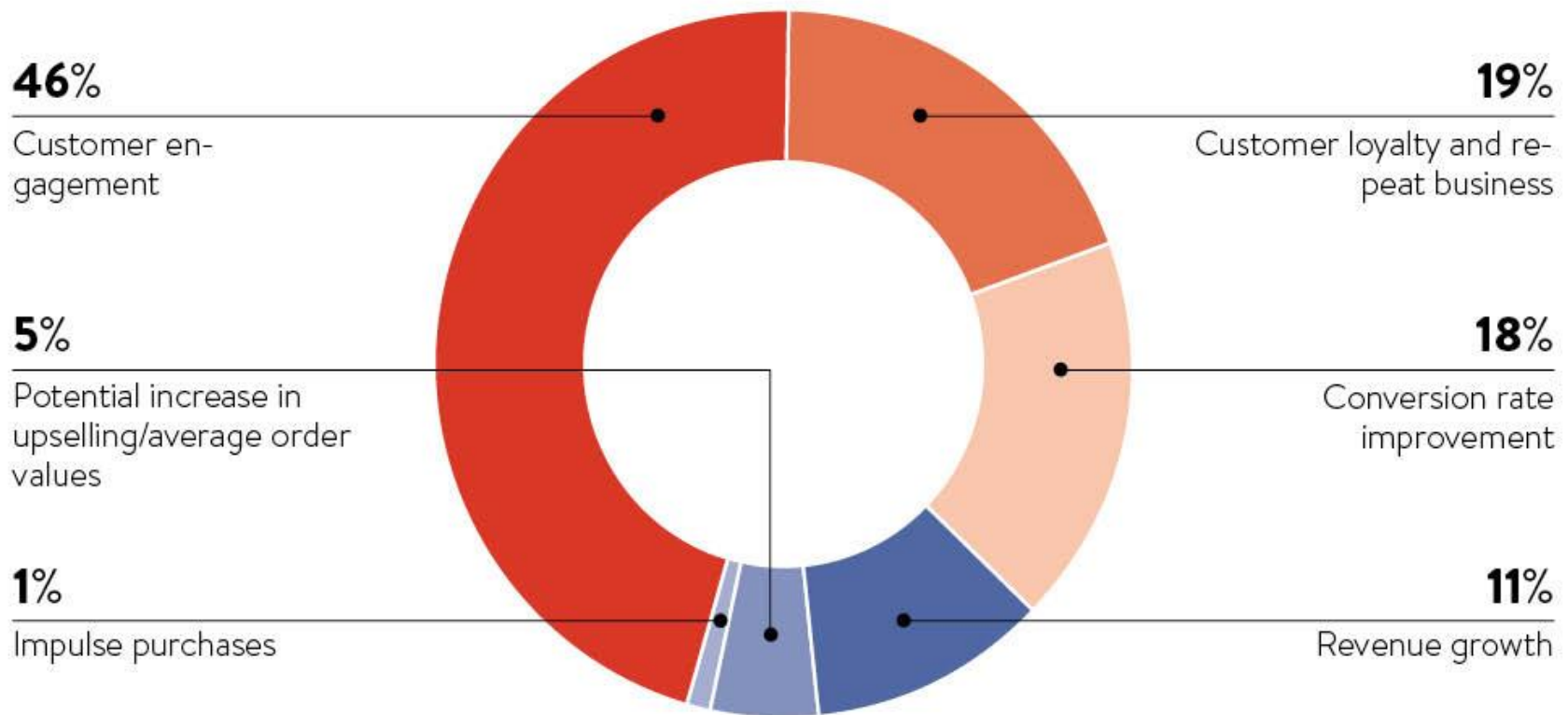
Sistemas ciber-físico e Automação



O impacto da 4ª RI

Personalização

MAIN BENEFITS OF PERSONALISATION TO RETAILERS

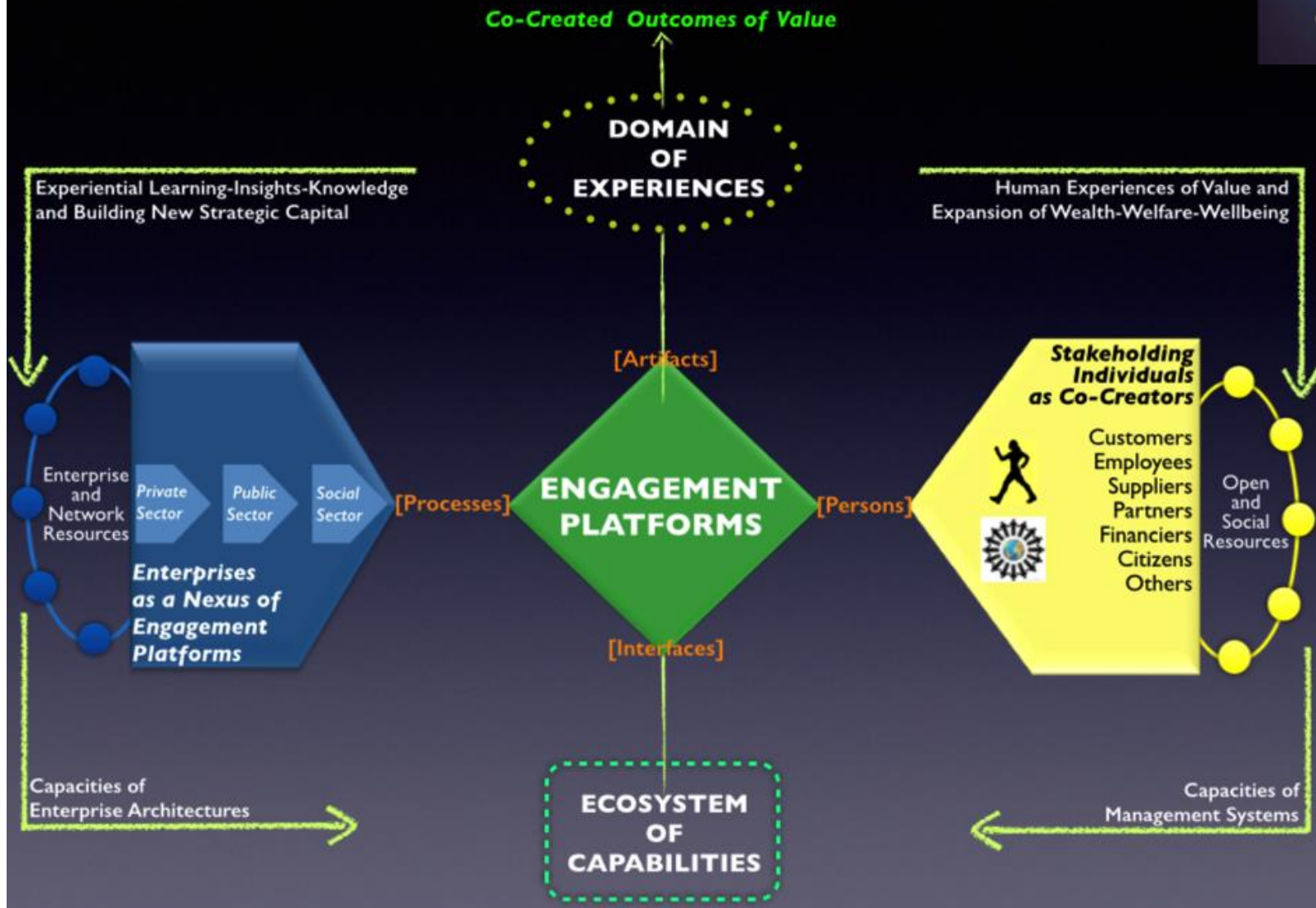
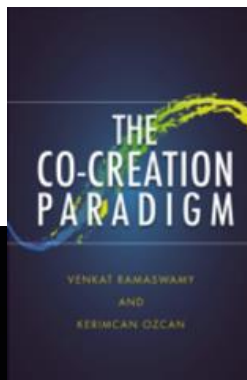


Source: Retail Week 2015

O impacto da 4ª RI

Colaboração e Cocriação

The Co-Creation Paradigm of Value Creation



O impacto da 4ª RI

Novos modelos de negócio (digitais)



U B E R

citydrive



airbnb



KHAN
ACADEMY



fintech



bitcoin



NETFLIX

Plataformas

Social

Colaboração e cocriação

O impacto da 4ª RI

Valor

- Industry 4.0 can deliver estimated annual efficiency gains in manufacturing of between 6% and 8%
- The Boston Consulting Group predicts that in Germany alone, Industry 4.0 will contribute 1% per year to GDP over ten years, creating up to 390 000 jobs
- Globally, the Industrial Internet will grow from US\$20 billion in 2012 to more than US\$500 billion in 2020, and that value added will surge from \$US23 billion in 2012 to US\$1.3 trillion in 2020
- The United States has established a National Network for Manufacturing Innovation with a proposed US\$1 billion of public funding
- Companies in the Asia/Pacific were expected to invest US\$10 billion in the Industrial IoT in 2012, with that figure rising to nearly US\$60 billion by 2020

Industry 4.0

Digitalisation for productivity and growth

EPRS | European Parliamentary Research Service

Author: Ron Davies

September 2015

O impacto da 4ª RI

Valor

“Total economic value-add from IoT across industries will reach \$1.9 trillion worldwide in 2020”

Gartner

“Fifty billion devices will be connected to the Internet by 2020”



“Cities will spend \$41 trillion in the next 20 year on infrastructure upgrades for IoT”



“The utility smart grid transformation is expected to almost double the customer information system market, from \$2.5 billion in 2013 to \$5.5 billion in 2020”

NAVIGANT
RESEARCH

“The industrial Internet could add \$10-15 trillion to global GDP, essentially doubling the US economy”



“Wide deployment of IoT technologies in the auto industry could save \$100 bn annually in accident reductions”

McKinsey&Company

“IoT developers to total 3 million in 2019”

ABIresearch
technology market intelligence

“75% of global business leaders are exploring the economic opportunities of IoT”

**The
Economist**

“The UK government recently approved 45 million pounds (US\$76.26 million) in research funding for Internet of Things technologies”

theguardian

O impacto da 4ª RI

Valor (triliões!)

IoT Market Size

(by 2025)

McKinsey&Company

\$6.1T



\$7.1T



CISCO

\$14.4T

Connected Devices

(by 2020)

Gartner

26B



32B



CISCO

50B

Data Growth

(2013 vs 2020)



Total Data

4.4ZB → 44.4ZB

10x

IoT Data

.09ZB → 4.4ZB

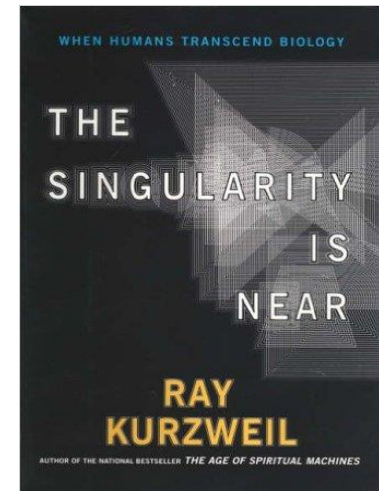
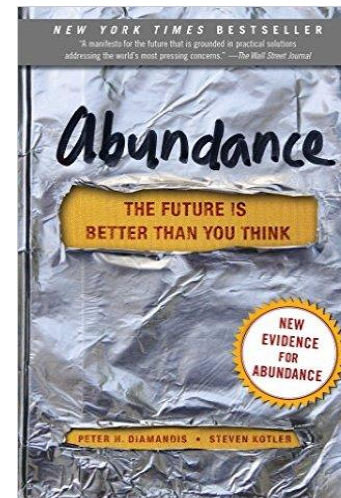
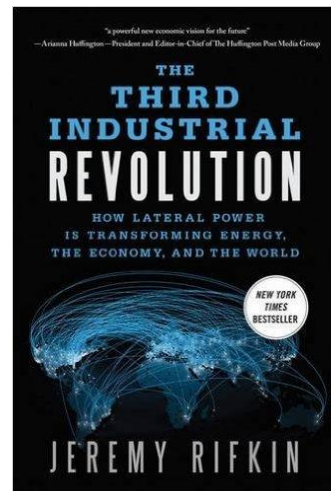
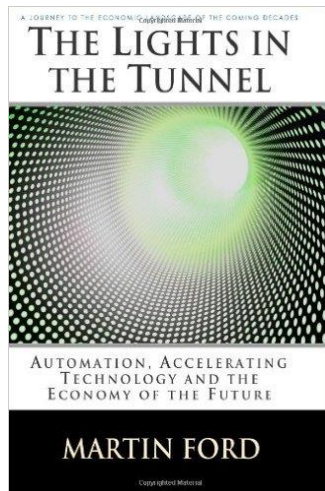
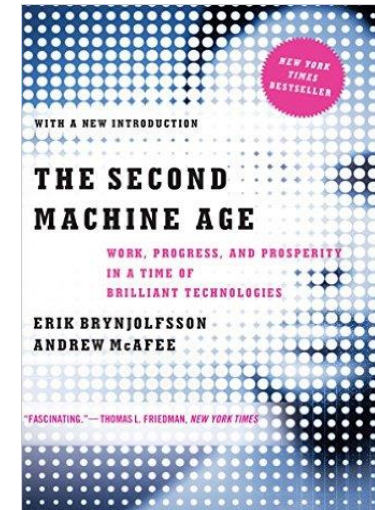
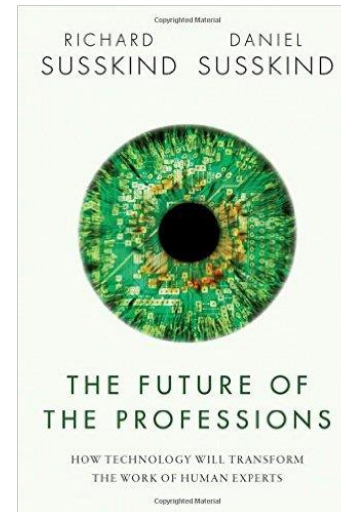
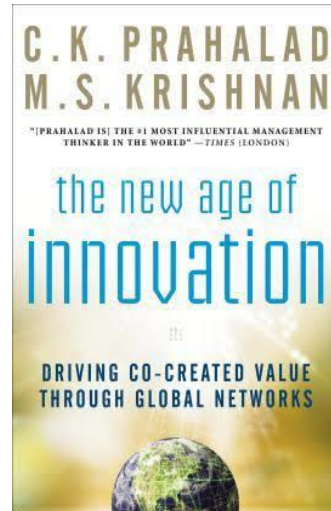
49x

O impacto da 4ª RI

Valor

O lado Bom!

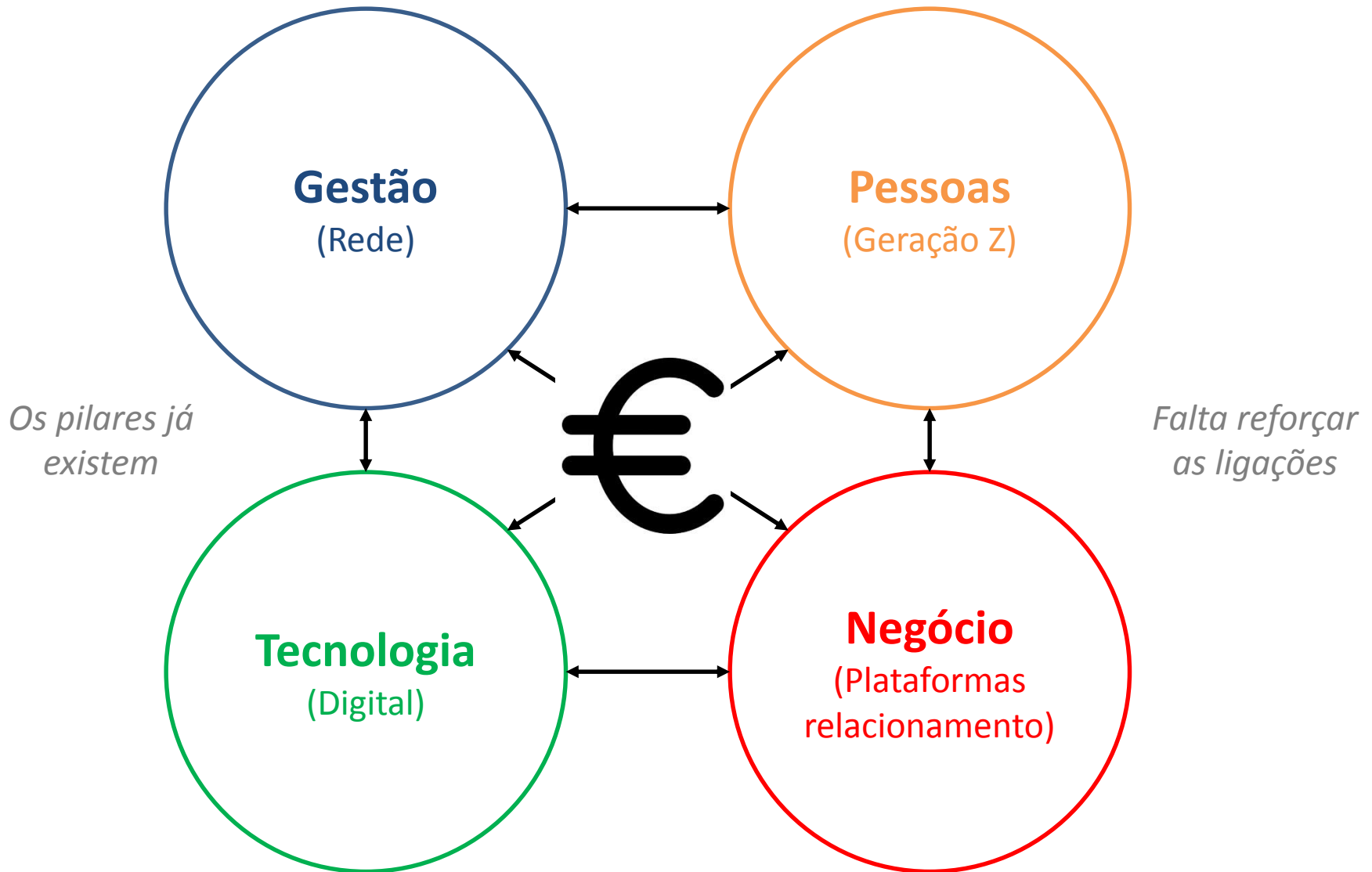
- Empresa
- Trabalho
- Educação
- Saúde
- Energia
- Liberdade



O QUE FALTA E OS PERIGOS

O que falta

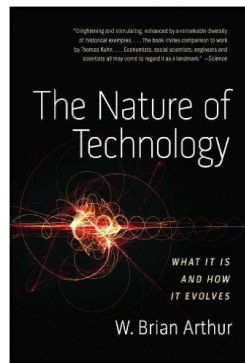
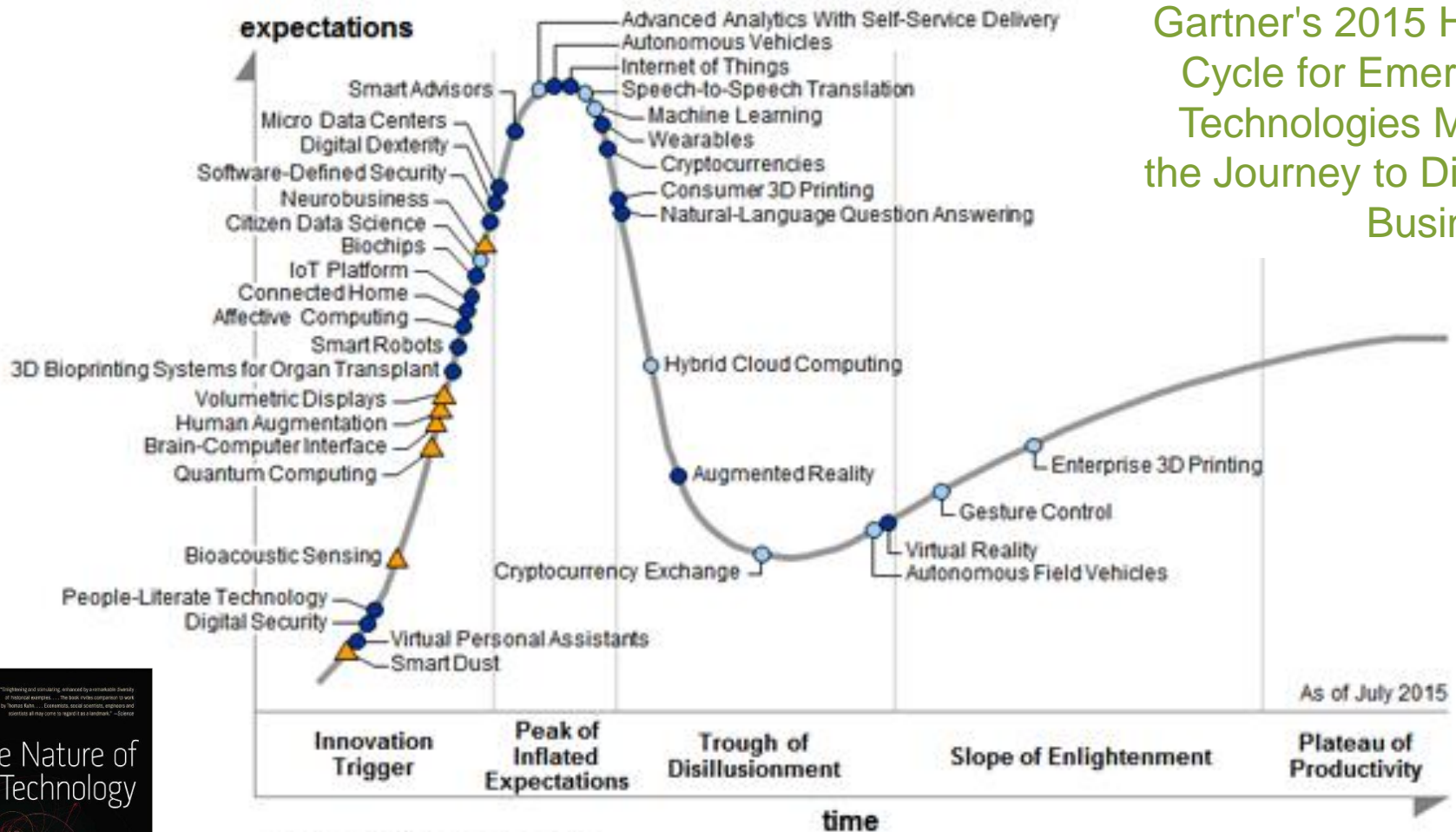
As ligações, investimento e mudança



O que falta

Maturação, difusão e adoção tecnológica (tempo!)

Gartner's 2015 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business



Estamos prontos mas ... vai levar tempo (Abernathy e Utterback)!

O que falta

Standards - A guerra já começou

How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025?

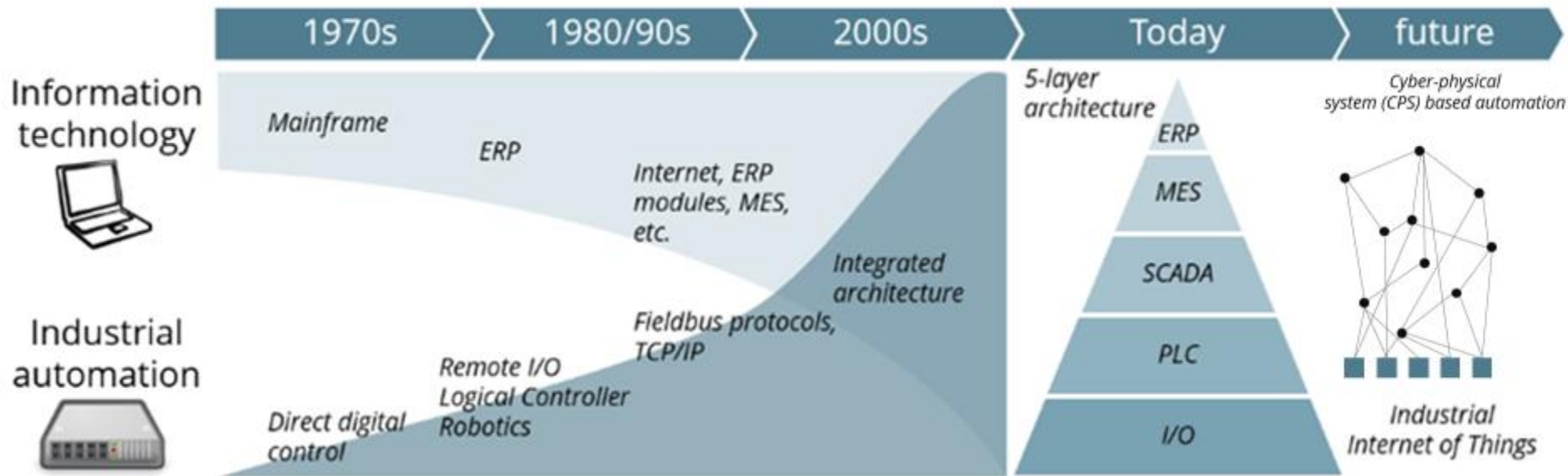


O que falta

Integração das TIC e Indústria – A fábrica inteligente

 IoT Analytics – Quantifying the connected world

Convergence of IT and automation

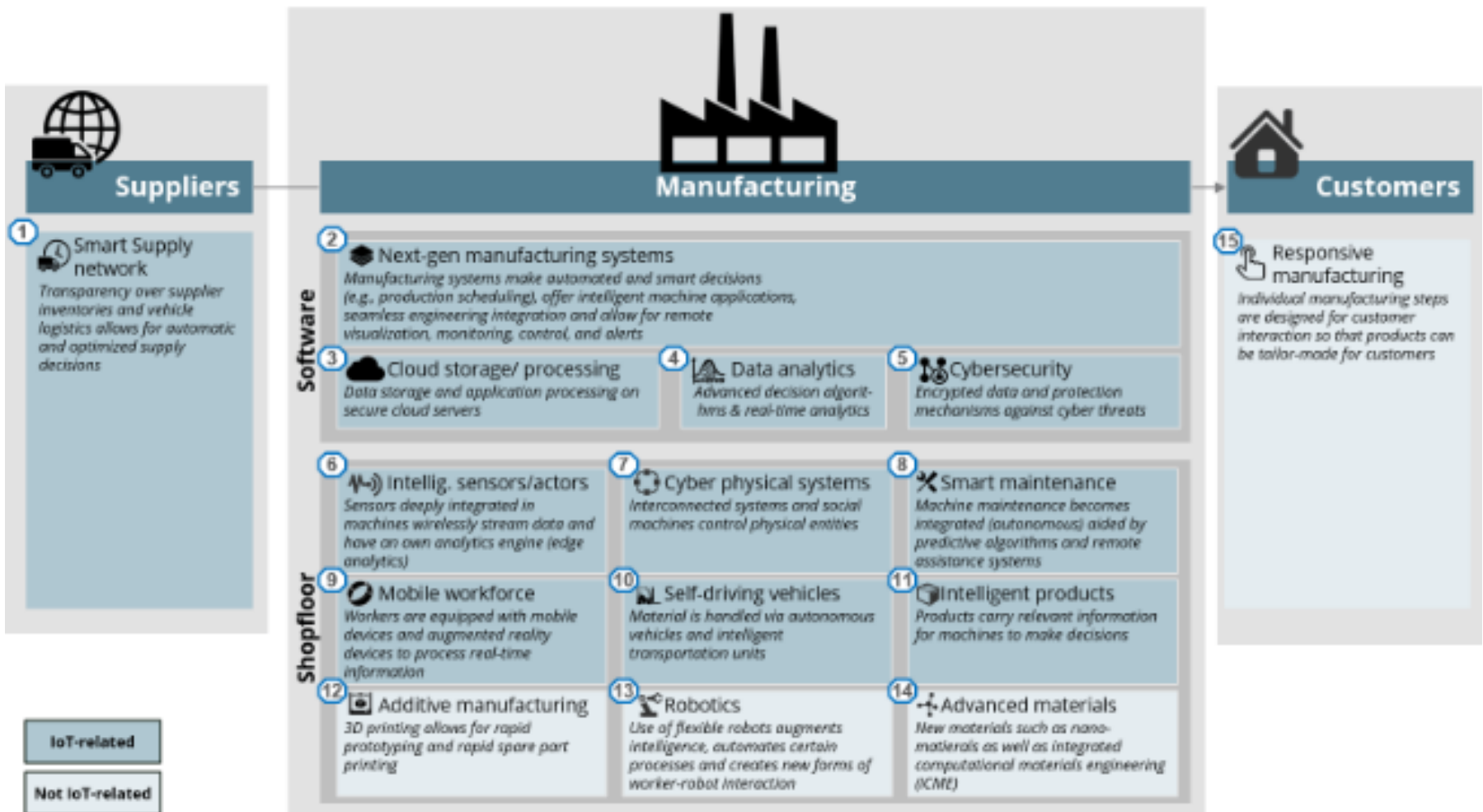


ERP = Enterprise Resource Planning MES = Manufacturing Execution System SCADA = Supervisory Control and Data Acquisition PLC = Programmable Logic Controller I/O = Input/Output signals Source: IoT Analytics

O que falta

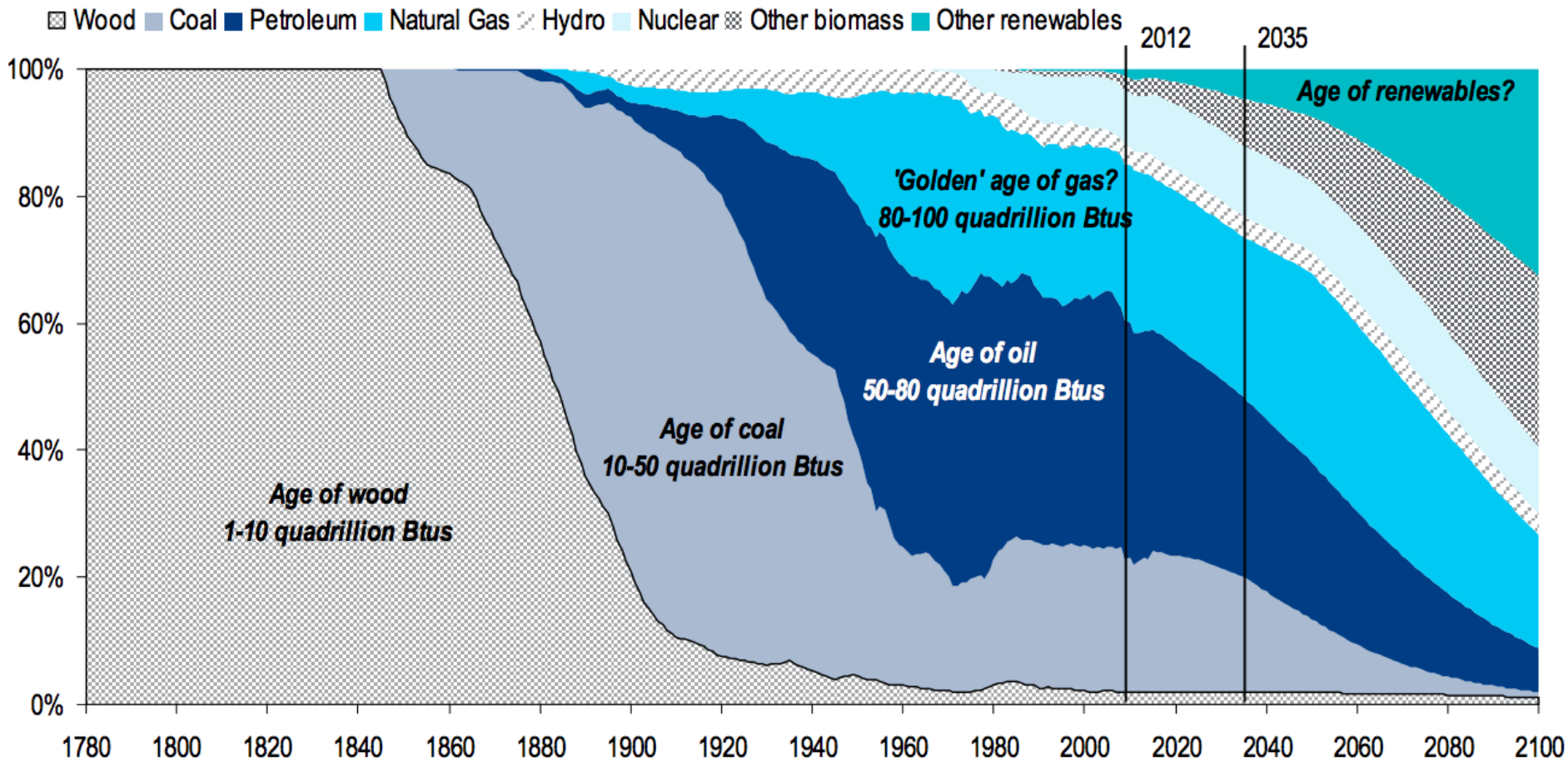
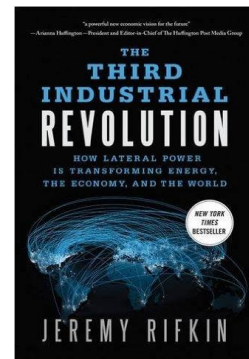
A fábrica inteligente - Produtividade

15 components of the smart factory of the future



O que falta

Energia barata, muita!



O que falta

Legislação, Políticas e Economia

Legislação

- Segurança dos dados
- Proteção pessoal
- Supervisão
- Responsabilidade
- Propriedade intelectual
- Emprego e desenvolvimento pessoal
- Incentivos à indústria e indivíduos



O que falta

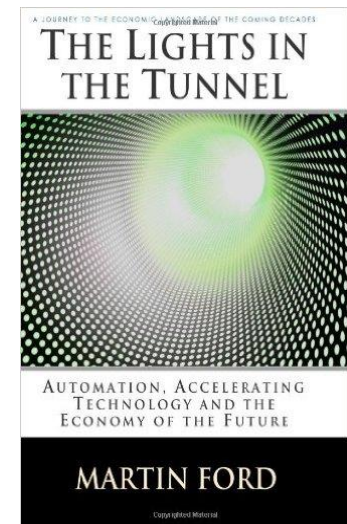
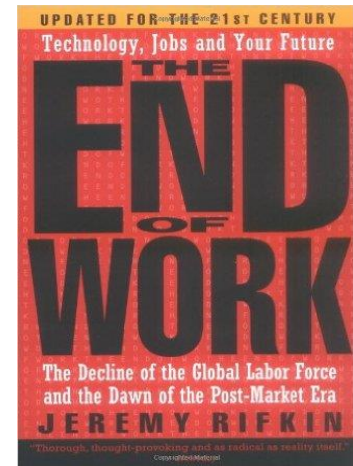
Legislação, Políticas e Economia

Cenário 1 – curto prazo

- As máquinas automatizam tarefas simples
- São eliminados empregos “não especializados”
- O que fazer com os trabalhadores nesta situação?
- E com os jovens a entrar no mercado trabalho?

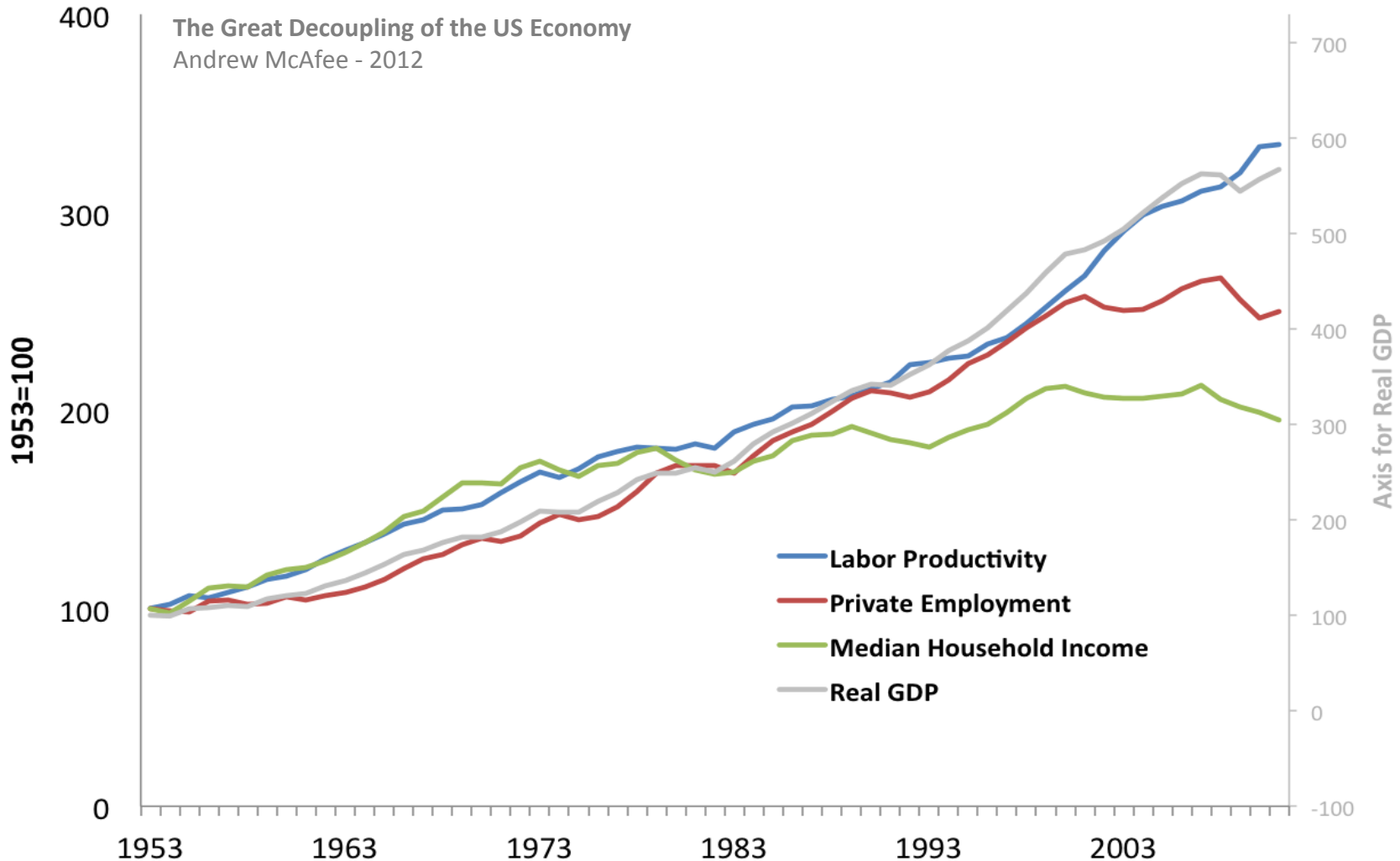
Cenário 2 – longo prazo

- A Indústria 4.0 elimina a maioria dos empregos
- O que fazer com o mercado do trabalho?
- Se não há trabalhadores, vai haver consumidores?
- O que fazer com a remuneração da empresas?
- Que economia para:
 - Desenvolver as pessoas
 - Distribuir riqueza e ajustar desigualdades
 - Criar infraestruturas e sistemas comuns
 - Desenvolver novo conhecimento e inovação



Os perigos

US Productivity, GDP, Employment, and Income: 1953-2011



Os perigos

Desemprego



Recessão



Homem vs. Máquina



CONCLUSÕES

Conclusões

A 4ª Revolução Industrial

Estamos a construir um “novo mundo”

- Tudo tem um rasto digital
- Tudo tem “iteratividade” e está conectado
- “Inteligência Artificial” e automação
- **Integração mundo físico e digital, homem e máquina**
- Aumento da **produtividade, recursos abundantes, crescimento**
- Precisamos de tempo, investimento e mudança processos
- **Relação trabalho vs consumo → Nova Economia?**

Estamos a construir as bases para:
a indústria sem trabalhadores, o homem-cyborg

A 4ª Revolução Industrial



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